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ENERGY UTILIZATION SURVEY PAMPHLET FOR BUILDINGS.(U)
APR 78 P E BAUM, H D HOLLIS

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(10) Peter E. Baum
Harold D. Hollis

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This pamphlet provides guidelines and forms to conduct an energy utilization survey of individual buildings and facilities on an installation. Forms are provided in this pamphlet for collection of information describing facility and individual building energy consumption. This information is needed to use energy conservation manuals which provide guidance on how to reduce and save energy through more effective operation of buildings and their mechanical and electrical systems, and through cost effective retrofit of existing systems. A list of these manuals is provided in Appendix A.

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ENERGY UTILIZATION SURVEY
PAMPHLET FOR BUILDINGS

1. This pamphlet provides guidelines and forms to conduct an energy utilization survey of individual buildings and facilities on an installation. Forms are provided in this pamphlet for collection of information describing facility and individual building energy consumption. This information is needed to use energy conservation manuals which provide guidance on how to reduce and save energy through more effective operation of buildings and their mechanical and electrical systems, and through cost effective retrofit of existing systems. A list of these manuals is provided in Appendix A.

2. The retrofit projects identified using the energy conservation manuals should be evaluated for MCA funding, using the guidance presented under the Energy Conservation Investment Program (ECIP), QRIP, etc. Economic analysis of projects is based on present worth techniques to determine a benefit/cost ratio for each project. To the extent that projects have been identified and analyzed in advance, projects will be prioritized in annual budget submissions based on the benefit (energy saved)/cost (investment) ratio.

3. Depending on time, manpower and budgetary constraints, the survey and appraisal of the buildings can cover either all or only certain selected buildings. This pamphlet presents the methods and contains the typical data forms needed for a comprehensive survey and analysis of building structures and energy systems.

4. Sources of Information

4.1 Facility personnel are a valuable source of information for updating of record data, and for obtaining practical energy conservation recommendations. The greatest impact on conservation results are obtained when the survey team and operating personnel pool their individual skills. Facility management should make operating and maintenance personnel available for the surveys.

4.2 Documentation associated with maintenance activities should be made available to the survey team to look over.

4.3 Records, drawings and specifications, "as-built" for all systems, control system layouts, functional descriptions and operation and maintenance manuals can be utilized to estimate the energy requirements of most buildings.

5. Conducting the Survey

5.1 The survey should be performed on those facilities and buildings selected via the criteria given in the Energy Audit Pamphlet for Installations.

The data and information collected during the survey should be recorded on Forms 1, 2, and 3 in Appendix B. The survey forms can provide the field survey team with an orderly and organized means of recording those building energy characteristics which should be known for rational energy conservation analysis.

5.2 A working schedule should be set up between the survey team and operations and maintenance personnel to ensure the survey team adequate time with knowledgeable personnel.

5.3 Form 1 is used to develop a facility type, construction and use profile. Form 2 is for the facility mechanical and electrical systems profile, and Form 3 is for the facility system's energy consumption profile. Form 3 requires information from the facility BTU or energy consumption meters, or from fuel and utility bills. If this data does not exist for each facility then Form 3 should not be used.

5.4 The building survey is a physical reconnaissance of a building for the purpose of verifying previous information collected in the installation audit and identifying defects in a building and non-energy conserving practices which when corrected or modified will bring about cost-effective reductions in energy requirements. The building survey must be thorough enough to accurately assess the major factors which contribute to the consumption of energy for the building.

5.5 Another important aspect of the building survey is the identification of condensation problems. Winter moisture accumulation in the sidewalls of buildings often leads to a paint failure problem. Excessive moisture accumulation may actually cause rotting of wood siding as well as wetting thermal insulation and reducing its insulating properties. Before additional insulation is installed in a ceiling, it is imperative that potentially dangerous condensation conditions be identified (such as improper attic ventilation), and corrected since more insulation may aggravate the problem. The identification of condensation problems is covered in Section 8.

6. Survey Procedure

6.1 The first step is to collect existing construction, engineering and as-built plans and drawings for the details on the building configuration, construction, HVAC system and site dimensions. These drawings and plans will supply most of the information needed to fill out Forms 1 and 2. The original plans should be used with caution since mechanical and electrical systems, as well as the original construction in older buildings have frequently undergone changes. Verify the information during the on-site building survey and obtain any additional information not provided on the plans or drawings.

6.2 The survey should not incorporate just the building itself, but it should include the building occupants, managers, custodian, etc. These persons should be contacted and queried about the living or working conditions of the building. Is the building overheated or overcooled? Do they have any control over the HVAC system? Does anyone perform temperature setback during unoccupied periods? Is there any response to their request for maintenance or repair? What maintenance or repair needs to be done? etc.

6.2.1 These and other questions will help the survey team to identify hidden problems or incorrect operations of the building HVAC system.

6.2.2 Generally uncomfortable conditions in the building are caused by one of the following factors:

-- Malfunction or improperly located thermostat.

-- Inoperative manual controls on heating terminals.

-- Improperly zoned buildings.

-- Mechanical system failure.

-- Inoperative automatic controls.

6.3 After a survey of the selected buildings has been completed, a Facilities Engineer should be in a position to identify a number of energy conservation projects for the buildings. To assist in quickly identifying those areas having the greatest impact on or potential for energy conservation, some major target areas to survey are outlined in the next section.

7. There are three major areas to investigate when conducting the building survey. These areas are excessive heating and/or cooling of the building, structural defects which cause air infiltration, and facilities used for purposes other than those designed for.

7.1 Excessive heating and cooling - There are some buildings in which there is excessive heating or cooling, or where the heating and cooling systems are running simultaneously. Occupant reaction varies from tinkering with controls, adding or removing outer clothing, or opening windows and doors in an attempt to alleviate the discomfort condition. Wherever these conditions are present you have a potential energy wasting building. The ideal time to search for these conditions is in weather extremes of heat and cold. During these extreme periods the effects are much more readily identified; the causes however are not.

7.1.1 Malfunctioning controls, adjustment of controls by unauthorized personnel, and controls being improperly influenced by the environment are some other major causes of wasted energy. The environmental causes may be radiation from other heat sources such as the sun or excessive air movement over the control or behind the wall in which the control is mounted.

7.1.2 Sometimes the design of the heating system is the cause of overheating or under heating. This may occur with a system using a chilled water coil into which pre-heated air is introduced. Control malfunction or modification of the original design may have resulted in a preheat cycle that is not matched to the load requirements.

7.1.3 Make-up air requirements may have been adjusted to meet the fresh air regulations for public occupancy. Motorized controls used to regulate fresh air intake dampers should be tested and should normally return to a closed position if fresh air is not required. Usually in public buildings no fresh air is required for unoccupied periods. However, prior to the energy shortage many systems were designed with first costs in mind, rather than the minimization of life cycle operating costs. Consequently, adequate controls were frequently deleted from the design. There are sophisticated control systems now available that can return their initial costs in energy savings within a few years. There are many specialists in this field that can provide guidance in the selection of the right control system package.

7.1.4 Buildings exhausting large amounts of indoor air may be energy wasters. Vapor plumes caused by warm moist air exhausted into cold atmospheres may be outward evidences of energy waste. Normally, however, warm air exhausted to the outside depends on the function of the buildings. For instance, dining halls and recreation centers require almost constant ventilation while PX stores do not. Therefore, each individual case must be considered separately. Another effect of exhausting air from the building interior is to create a negative pressure and to substantially increase the infiltration of outside air. The pressure difference in extreme cases may make opening and closing of entry doors difficult. The inside-to-outside pressure difference often creates a moaning sound around the doors and windows as the air is pulled inward or blown outward. The effect on the operation of the heating and cooling system may unbalance the system causing erratic temperature control. Under extreme conditions, the infiltrated air (especially if it is cold) will cause a variety of occupant reactions. These vary from artificial barriers, rags, etc., stuffed in crack openings and blocking materials placed over distribution outlets and returns. In summary, significant energy savings may be achieved by reducing the amount of indoor air that is exhausted to the outside.

7.1.5 When freight doors are open during loading and unloading a great deal of energy is wasted by attempting to provide space heating for a warehouse when one side of it may be literally open to the outdoors during

loading and unloading operations. There are, however, certain corrective alternatives available such as the use of expanded rubber dock doors that form an air seal to the back entrance of large trailer trucks.

7.1.5.1 Several side effects show up as a result of the freight doors remaining open. Not only is indoor air flushed from the bay which is served by the open door, but it may also be flushed from other areas under certain conditions. Due to the extraordinary quantities of air exchanged in this type of operation, a good deal of dirt laden air is circulated and deposited on heating system components. This tends to further aggravate energy waste by reducing the operating efficiency of the heating and cooling plants.

7.2 Buildings with Structural Defects - There is the obvious hole in wall and the not so obvious hole. A gaping 6 sq ft hole is more readily identified and repaired than are a series of cracks through which air leaks, even though the sum of these cracks may be equal to a 12 sq ft hole. These "little openings" tend to be overlooked because they are cracks; however, each one is a defect and will very likely get worse, not better, leading to further deterioration. The greater the difference between inside and outside temperatures, the more likelihood small fissures will become big problems, especially in a zone in which freeze/thaw conditions are continuous for three or four months out of the year. Structural defects for various parts of a building which will result in significant heat loss due to infiltration are described in the next section.

7.2.1 Foundations and basements - There is often an opening between the sill plate and the top of the foundation wall of wood frame buildings. The moving air may not be readily seen, but it can often be detected by holding your hand in the suspected area. Smoke from a cigar or cigarette may also be used to identify air infiltration. Trace all water, gas, electrical conduit, and communication equipment wiring to their entry points and check for gasketing or properly installed caulking around the penetration. Other sources of infiltration are windows, coal access doors, outside entries to the basement area, and underground trenches carrying steam lines or communication wiring.

7.2.2 A check also should be made for old furnance flues now unused because of replacement of the heating plant with a non-combustion type. These flues should be capped at both ends. The effect of air passing over an open chimney creates a negative pressure at the base of the flue and induces air infiltration.

7.2.3 If the basement is under only part of the building, look for access holes to other unheated regions such as crawl spaces. These regions may or may not be vented.

7.2.4 Slabs on Grade - Air leaks occur where the wall has parted from the slab or where there is a penetration through the slab. These openings may not be visually detected from either the inside or the outside unless smoke is used as outlined in the section under basement air leaks. Telltale signs of air leakage are inside traces of moisture at the wall/floor interface. Also look for water stain marks on baseboard trim or on the walls. There may be evidence of water damage to flooring materials at the perimeter edge which is also a likely indicator of an air leak. Caution - the lack of effective perimeter slab insulation may also be the cause for condensation or frost, and result in water damage along slab perimeters. Also, under certain adverse conditions, hydraulic water pressure may force water up through small hair-line cracks in the slab itself and cause damage.

7.2.5 Unheated Crawl Spaces - A crawl space is usually found only under bachelor quarters, barracks, or family housing units. Access is limited and detailed inspection is a less than pleasant chore. The crawl space is frequently one of the major contributors to, or direct causes of, other structural or operational problems for these types of buildings. The crawl spaces should be checked during times of freezing weather.

7.2.5.1 All plumbing, including traps on sanitary sewer lines should be insulated to Army specification in the crawl spaces. Air may also be found entering around plumbing pipes, especially to bath tubs. Check the plumbing access panel behind a tub to verify this condition. Air may also be infiltrating around chimney flues which have their foundation beginning in crawl spaces. Large holes for electric wire or conduit to pass through interior walls may also be detected by feeling around outlet or switch plates. As a general rule, however, the worst conditions will usually be found where oversized openings have been made to accommodate plumbing and heating pipe runs.

7.2.6 Air conditioning equipment should also be checked for unusual noise and abnormal accumulation of debris. If winterizing covers are needed, they should fit snugly to the unit.

7.2.7 Ceiling/Roofs - An important aspect of the inspection of the building interior is the space between the finished ceiling and the roof. The attic may be six inches or six feet in height, but without exception it must incorporate two components. They are, insulation and adequate ventilation.

7.2.7.1 A visual inspection may be difficult due to space restrictions but look for evidence of unvented moisture collecting on the underside of the roof sheathing. Water stains, rusty fasteners, mildew and dry rot are all signs of high moisture concentrations.

7.2.7.2 Wherever there is a penetration through the roof, look for evidence of water leaks. In geographical areas of 7000 degrees days or greater, snow loads on roofs can exceed structural support ratings. Broken or distorted support members are readily identified.

7.2.7.3 The roof is the "forgotten" member of the building. "Out of sight, out of mind" is a trite but apt expression epitomizing the attention normally given to this important component. The "if it doesn't leak, it must be OK" theory may be self-reassuring, but it is no substitute for knowing ... especially so if a leak condition is in the formative stage. For shingle roofs, check the ridge lines for sagging and look for curled shingles (evidence of moisture in roof sheathing), torn or missing shingles, and loose flashing.

7.2.7.4 For "built-up" roofs, look for standing water, plugged storm drains, imperfectly sealed expansion joints and imperfectly sealed flashing at roof edges, parapet walls and roof penetrations.

7.2.7.5 Not easily detected are small bubbles, wrinkles, or heaving which may be caused by conditions of moisture, temperature, stress, or other structural faults already mentioned.

7.3 Facilities used for purposes other than those designed for is the last area to investigate during the building survey.

7.3.1 Some examples of alternats uses are:

A. The barracks converted to offices.

B. The warehouse converted to offices.

C. The shed converted to a service shop.

D. Basement rooms converted to day rooms.

There are more conversions of course, but the important observation is, does the conversion operate satisfactorily? Was it done on the basis of meeting a temporary need which became permanent or was there a long range plan?

7.3.2 If the installation has become "permanent", examine it with the same procedures described before. Be especially alert to the light construction materials applied to offices constructed within older buildings. There will usually be no insulation applied and conditioned air loss is exceptionally high due to the light construction materials and their loose fit.

8. Identifying Condensation Problems:

8.1 The identification of moisture problems is an important aspect of the building survey. Moisture accumulation in wood siding may lead to paint failure. Excessive moisture accumulation may actually lead to wood rot which may substantially shorten the life of a building. Moisture may also accumulate in the sidewall insulation material, thereby reducing its insulating properties.

8.2 Since paint failure may also be caused by poor surface preparation and a poor paint system, it is necessary to look for other symptoms in order to diagnose a moisture problem. Toward the end of the winter season, a close examination of a newly painted surface may reveal water blisters. Bowed and warped boards may also be observed. And finally, pushed-out nails may sometimes be present. If paint peeling by itself is observed without the presence of any of the other foregoing symptoms, then there is a good chance that the paint peeling is not moisture related.

8.3 The two principle causes of excessive sidewall condensation are the lack of or an improperly installed vapor barrier or excessive indoor humidification. During the building survey, the presence of indoor humidifiers should be noted. A good indication of excessive humidification is water marks on the inside wall surface under the windows. These marks are due to water that has condensed on the window panes during the winter season. If signs of a moisture problem are observed during the building survey, an inspection of the vapor barrier should be made by removing a siding board.

8.4 During the building survey, it is important to note the status of attic ventilation openings. In the past some attic ventilation may have been inadvertently closed off. The addition of insulation to a ceiling of a completely closed-off attic will often lead to a very serious condensation problem. The increased amount of ceiling insulation substantially reduces attic temperatures and thereby significantly increases the likelihood for water vapor to condense on cold surfaces. It is extremely important that closed-off ventilation openings be reopened before more insulation is installed in an attic.

9. The last part of the audit is to prepare a profile of the existing consumption of energy for each facility and recording the data on Form 3. As mentioned in Section 5.2 this part of the audit should only be performed for those facilities which have energy consumption meters or bills which have the actual quantities of fuel and power used, whether it be oil, gas, electricity, etc.

9.1 The ultimate savings in energy due to a conservation project can usually be expressed as a percentage of a facility's current consumption.

Energy conservation measures should be considered by individual systems and subsystems, and so it is important to break down the total amount of energy used into each subsystem, whether it be heating, cooling, lighting, etc.

9.2 Total the gross number of BTU's used for the year and enter the result on line 1g of Form 3. Then determine the BTU's used per sq ft of gross floor area for the year, and record this number on line 1h.

9.3 Table 1 was derived from "Building Heating Energy Consumption at Fixed Facilities," Report No. FESA-RT-2034. In the report, oil delivery data were collected for various building types at three Army installations in the Washington, DC area. These data, collected for FY75 and FY76, were analyzed to determine the heating energy consumed by the different building types. The average heating energy consumption in BTU's as well as the high and low sample were calculated and plotted for each building type. The data in Table 1 should be normalized on the basis of heating degree days or extrapolated through inference by square footage. Comparisons can be made between the values given in Table 1 and actual consumption rates on a given installation.

9.4 The next step is to break down the average annual BTU consumption by system, (heating, cooling, lighting, etc) and record the data in Sections 2 through 6 of Form 3.

9.5 Fuel bills often do not differentiate between the end use for heating or other purposes, so an adjustment must be made. If oil, gas, or coal is the primary fuel, and is used for both heating and domestic hot water, the usage should be broken down between the two. The space heating load occurs in the winter, but the domestic hot water load is continuous for the whole year at a rate that can be attributed only to heating the water. Select one average winter month's consumption, subtract one average summer month's consumption and multiply the answer by the total number of heating months to arrive at the heating consumption. The difference between total fuel used and heating fuel use will approximately be the domestic hot water energy consumption.

9.6 If the building is heated by electricity and the total electrical usage of the building is metered and billed in a lump sum, the bill will include energy for heating, lighting, and power. To arrive at the amount of electricty used for heating only, it is necessary to assess the quantity used for lighting and power and subtract this from the total billing. An assessment of the electricity usage for lighting can be made by counting the number of lighting fixtures and multiplying the wattage of each lamp and the average number of hours that these are switched on during the heating season. Most of this information should have already been tabulated on Form 2. This will give the total number of watt-hours consumption that can be attributed to lighting. Divide watt-hours by 1000 to get

Table 1

Building Heating Energy Consumption at Fixed Facilities

Building Type	Annual Energy Consumption ($1000BTU/ft^2/year$) High	Low	Baseline
Enlisted Men's Bks.	255	60	136
BOQ	250	25	102
Family Housing (Officers)	175	40	85
NCO Family Housing	170	50	64
Admin., Offices	235	50	86
Warehouse	190	15	93
Motor Rep. Shop	750	10	176
Chapel	225	30	156
Laboratory	410	90	100
General Inst. Bldg.	420	40	123
Mess	175	60	101
Bks with Mess	115	60	86
Post Exchange	205	55	106
Recreation Center	150	90	99
Theater	280	190	213

kilowatt-hours. Similarly, a survey can be made of all electrical motors that are in use during the heating season and their nominal horsepower rating multiplied by .800 to determine the approximate amount of electricty in KWH used for each hour of running. This formula assumes an efficiency of 93% for electric motors. The KWH should then be multiplied by the number of hours of operation during the heating season to determine the total kilowatt hours that can be attributed to power. The sum of the kilowatt hours assessed for lighting and power should then be subtracted from the total electricity consumed by the building during the heating season to determine the amount used for heating. In large complex buildings where simultaneous heating and cooling are likely to occur, you should seek professional help to prepare a more accurate analysis of energy flow, if your maintenance staff is unable to do so. To determine the energy used for lighting and for power for the entire year, the same method of determining energy use in the heating season, described above, can be used for a 12-month period.

9.7 To determine the amount of energy used for air conditioning, estimate the energy for fans and pumps as outlined above. For electric driven refrigeration units the KWH can be estimated by deducting the energy used for lighting and other motors from the June, July, August, and September electric utility bills.

10. The end result of performing the installation energy audit and the building survey will be to aid in identifying potential retrofit options and preparing preliminary cost estimates for these options. Energy inputs needed to achieve required energy related services in installation facilities, including thermal comfort, illumination, hot water, and other functional services can be significantly reduced through improvements in facility design (retrofit) and in operational procedures. A considerable amount of information and guidelines are available in numerous engineering and government manuals (See Appendix A) to help identify both the potential methods for reducing energy requirements and the energy savings that can be achieved through their use.

10.1 In some cases, significant improvements can be made at little or no cost and are therefore immediately attractive. In general, however, physical improvements to installation facilities which reduce energy consumption without reducing the quality of related services are costly enough to require some economic justification. Moreover, where some of these improvements can be utilized at two or more district levels of application (such as insulation), an analysis is required to determine which of these utilization levels is the most economically justified.

10.2 As energy prices increase relative to the cost of energy conservation improvements, greater levels of investment in energy conservation should be considered to offset these higher energy costs. The Energy Conservation Investment Program (ECIP) provides the framework for making such economic

considerations on a systematic basis. The framework is based on present worth techniques to determine a benefit/cost ratio for each project. The analysis requires that all benefits and cost incurred throughout the economic life of energy related improvements to base facilities be compared on a consistent, time equivalent basis. The method used to make all these benefits and cost consistent is presented in the Deputy Assistance Secretary of Defense (I&H) memorandum on Energy Conservation Investment Program (ECIP) Guidance, dated October 21, 1977.

APPENDIX A

1. Federal Energy Administration, "Guidelines for Saving Energy in Existing Buildings," June 16, 1975, ECM 1 and ECM 2, Conservation Papers Numbers 21 and 22, **1975-621-727/2811 I-3 and 1975-621-727/2812 I-3.

2. National Bureau of Standards, "Technical Options for Energy Conservation in Buildings," prepared for Joint NBS/NCSBCS Emergency Workshop on Energy Conservation in Buildings. Gaithersburg, MD., June 19, 1973.

3. Federal Energy Administration, "Identifying Retrofit Projects for Buildings, September 1976, FEA/D-76/467, Price $2.00 **Stock No. 041-018-00129-8.

4. "Life Cycle Costing Emphasizing Energy Conservation" ERDA-76/130.

5. "Retrofitting Existing Housing for Energy Conservation: An Economic Analysis", NBS BSS-64, December 1974.

FORM 1

DATA SHEETS FOR THE

BUILDING SURVEY

BUILDING NUMBER ____________

BUILDING NAME ____________

SURVEYED BY: ____________

SURVEY DATE: ____________

1. General Information:

Address ____________________

Primary Use ____________________

Person(s) in charge of Building: ____________________

Sketch plan of building, show orientation and major dimensions.

Form 1 (cont'd) Building No. ___________

2. Building Construction Data

   A. Gross floor Area (outside dimensions) ______________ sq. ft.

   B. Number of Floors _________

   C. Walls - List material and thickness of each layer of wall (from inside out) example: Wallboard - ½", 2" x 4" studs with 2" insulation, plywood - ½", Aluminum Siding - 1/8"

   ____

   ____

   ____

   ____

   D. Floors

   Type: (Check all appropriate items)

   Slab on grade __________ Percentage Over unheated space __________

   Wood ________________

   Concrete ________________ Other ___________

   Tile ________________

   E. Roof

Type:	Color:	Material:
Flat ________	Light ________	____________
Pitched________	Dark________	____________
		____________

If insulated give thickness ______________________.

Form 1 (cont'd) Building No. _______

F. Ceiling, if insulated

Type insulation _______________

Insulation Thickness ____________

3. Exterior Envelope

A. Fenestration

(1) Type of Window and Glazing (indicate approximate percentage)

Type ____________ Fixed sash, double hung, casement, other

Single Pane ________________

Double Pane (Insulating) ______________

Single Pane with Storm Window ______________

Clear ____________________________________

Reflective ______________________________

Heat Absorbing ___________________________

(2) Shading Devices (check as appropriate)

Awnings __________________________

Solar Screens _____________________

Fins _____________________________

Interior Shading (indicate type) _____________

Natural (trees, scrubs, etc.) ________________

Other ___________ _____________________

None ______________________________________

Form 1 (cont'd) Building No. ________

(3) Assessment of Beam Radiation through Windows

(fill in table)

Exposure	Type[1] Glazing	Surface area ft^2 Wall	Windows	Doors	Estimated Shading (indicate fraction)
N					
S					
E					
W					

1. See item 3.A.1

Form 1 (cont'd) Building No. __________

B. Air Leakage (check as appropriate):

Structural damage (through the wall/ceiling cracks) ______________

Broken or defective windows ______________

Ventilation Exhausts that remain open all the time ______________

Tightness around windows and doors ______________

Note other major observed air leaks ______________

____

____

4. Maintained Indoor Conditions (fill in table):

Season	Day Temp. °F	Day RH %	Night Temp. °F	Night RH %
Winter				
Summer				

A. Note any problems with maintaining desired indoor conditions. ______

____

____

____

____

Form 1 (cont'd) Building No. ________

5. Occupancy Schedule, including custodial hours. (fill in table):

   Peak Number of occupants ____________.

Day of Week	Percent Occupancy		
	0800-1600	1600-2400	0000-0800
Sun.			
Mon.			
Tue.			
Wed.			
Thurs.			
Fri.			
Sat.			

6. Outside Air Ventilation * (CFM)

   During occupied hours ______________

   CFM/person ______________________

   During unoccupied hours______________

*If unavailable locate outside air damper and note position (open, closed, fraction)

Form 1 (cont'd) Building No. ______

7. Remarks concerning occupant discomfort: ______________________________
____
____
____

8. Remarks concerning signs of condensation damage ____________________
____
____
____
____

FORM 2

ELECTRICAL AND MECHANICAL PROFILE

BUILDING NO. __________

(Circle appropriate items and fill in blanks)

1. Electric lighting system

Lighting fixtures in primary spaces such as office areas, halls of worship, store sales areas.

(1) Incandescent; (2) Fluorescent; (3) Other note________________

(4) # of fluorescent fixtures________; # of lamps per fixture________;

(6) Wattages per lamp__________; (7) Total wattage of all fluorescent fixtures__________; (8) Total wattage of all incandescent lamps______;

(9) Total wattage of incandescent and fluorescent lamps_______________;

(10) Estimate average percentage of lights used during normal operation ____________________°

2. Lighting fixtures in secondary spaces, such as corridors, toilet rooms, storage rooms.

(1) Incandescent; (2) Fluorescent; (3) Other note__________________;

(4) # of fluorescent fixtures__________; (5) # of lamps per fixture _________; (6) Wattages per lamp__________; (7) Total wattage of all fluorescent fixtures___________; (8) Total wattage of all incandescent lamps_________; (9) Total wattage of incandescent and fluorescent lamps____________; (10) Estimate average percentage of lights used during normal operation______________.

3. Total installed wattage: Lines 1 (9) + 2 (9) = ___________

4. Average installed watts/sq. ft.____________.

5. A. Type lighting fixtures: (1) Pendant mounted; (2) Surface mounted; (3) Recessed; (4) Wall mounted; (5) Luminous ceiling; (6) Cove mounted; (7) Exterior lighting on walls; (8) Exterior lighting on standards.

Form 2 (cont'd) Building No. ______

B. Are the lights turned off during unoccupied periods? ________

HEATING AND AIR CONDITIONING SUPPLY

6. Boilers or furnance type for space heating (Circle appropriate items)

(1) Hot water; (2) Low pressure steam; (3) High pressure steam; (4) Fire tube; (5) Water tube; (6) Cast iron; (7) Steel; (8) Gravity hot air; (9) Forced warm air; (10) Hot water converter.

7. a) Boiler or furnance rating ______________ BTUx10^3/hr. or

Boiler H.P. ____________________

b) Present measured peak load combustion efficiency __________ %.

8. Supplied Steam or Hot Water

a) Supplied from Boiler Plant No. ____________________

b) Amount supplied ____________________ lbs steam/GPM Hot Water/BTU/hr.

c) Steam pressure ______________ psi

d) Hot Water supply ______________ ^oF, Return ____________________ ^oF

e) No. hot water pumps ______________ HP ______________________

9. Compressors and chillers:

(1) Number ________________

(2) Rating of each in tons of refrigeration ________________

(3) Total tons of refrigeration (1) x (2) = __________________

(4) If electric drive, total motor horsepower ____________ H.P.

(5) If absorption units, total peak steam ______________

consumption _____________ lbs. steam

10. If central air conditioning systems, indicate: (1) Cooling tower motor sizes total _____________ H.P.; (2) Air cooled condenser motor sizes total ______________ H.P.; No. condenser pumps _________ Total ________________ H.P.

Form 2 (cont'd) Building No. ______

11. If room air conidtioners or through-the-wall units:

Indicate (1) total number ____________ (2) Horsepower ________/unit.

(3) Total connected Horsepower (1) x (2) = ______________________.

Line No. (Circle appropriate item and fill in blanks, if known)

12. If commercial refrigeration, indicate: (1) Number of cold cases or refrigerators________________; (2) Number of condensing units ______________ (3) Total connected horsepower of condensing units ________________ H.P.

HVAC SYSTEMS

Check the systems and fill in appropriate information,(if known)

13. All Air systems: Check types-fill in blanks.

(a) Single zone __________
- a) Number of air handling units ________
- b) Total Horsepower ___________________
- c) Total CFM/air handling unit ________

(b) Terminal reheat _____
- a) Number of air handling units ________
- b) Total Horsepower ___________________
- c) Static pressure ____________________
- d) Number of reheat boxes _____________
- e) Type reheat Coil: 1. hot water 2. electric 3. steam
- f) CFM/air handling unit ______________

(c) Variable Volume ____
- a) Number of air handling units ________
- b) Total horsepower ___________________
- c) Dump type system ___________________
- d) Vaned inlet ________________________
- e) CFM/air handling unit ______________

Form 2 (cont'd) Building No. __________

(d) Induction _______ a) Number of air handling units _______________

b) Total horsepower _______________

c) Static pressure _______________

d) Number of terminal units _______________

e) CFM/air handling unit _______________

(e) Dual duct _______ a) Number of air handling units _______________

b) Total horsepower _______________

c) Static pressure _______________

d) Number of terminal units _______________

e) CFM/air handling unit _______________

(f) Multi-zone units a) Number of air handling units _______________

b) Total horsepower _______________

c) Static pressure _______________

d) Number of terminal units _______________

e) CFM/air handling unit _______________

(g) Forced warm air furnaces No. _______________

a) Total horsepower of blowers _______________

b) CFM/furnace _______________

14. Water-air systems

(a) 2 Pipe fan coil __ a) Number of units _______________

b) Total connected horsepower _______________

(b) 4 Pipe fan coil __ a) Number of units _______________

b) Total connected horsepower _______________

(c) Unitary Heat Pumps _______ a) Number of units _______________

b) Total connected horsepower _______________

(d) Wall Radiators __ a) Number of units _______________

Form 2 (cont'd) Building No. ________

15. Pumps

(a) Chilled water pumps________________________________

a) Number of units____________________

b) Total connected horsepower__________

(b) Condenser water pumps________________________________

a) Number of units____________________

b) Total connected horsepower__________

(c) Boiler feed pumps________________________________

a) Number of units____________________

b) Total connected horsepower__________

(d) Hot water pumps for space heating________________________

a) Number of units____________________

b) Total connected horsepower__________

(e) Recirculating pumps for domestic hot water______________

a) Number of units____________________

b) Total connected horsepower__________

16. (a) Outside air fans________________________________

a) Number of units____________________

b) Total connected horsepower__________

c) CFM/fan unit____________________

(b) Supply air fans (Check the number and total H.P. for all)____

a) Number of fans__________ HP________

b) CFM/fan unit________________________________

Form 2 (cont'd) Building No. __________

(c) Exhaust air fans ____

a) Number of fans ______________ HP ______________

b) CFM/fan ____

17. Check if installed:

a) Fin tube radiators ________

b) Cast iron radiators _______

c) Radiant heating coils _____

d) Hot water piping __________

e) Supply and return ducts ________

f) Outside air dampers ____________

g) Steam piping __________________

h) Exhaust duct work ______________

18. Include a brief description of control system, operation and/or any other pertinant or unusual factors affecting HVAC system ______________

____

____

____

____

____

____

____

Form 2 (cont'd) Building No. ____________

DOMESTIC HOT WATER SYSTEMS

19. Method of generation and storage; Separate water heater;

    (1) Oil; (2) Gas; (3) Electric; (4) Coal; (5) Tankless heater on space heating boiler; (6) Tank heater on space heating boiler; (7) Hot water converter.

    (7) Storage tank size if any ______________gals.;

    (8) Tank insulation thickness __________ Type ___________

    (9) Aquastat setting ____________

20. Estimated annual usage:

    (1) Office Bldgs: form 4, Line 5 x 750 = __________gal/yr.

    (2) Restaurants: Form 4, Line 5 x 50 gal/yr = _________gal/yr.

    (3) Religious Bldgs: Form 4, Line 5 x 50 gal/yr = ________gal/yr.

    (Does not include special cooking facilities)

    (4) Stores: Form 4 Line 5 x number of days = ___________gal/yr.

    (5) For residential buildings - 7200 gal/capita/yr. = _____gal/yr.

    (6) For schools - 50 gal/capita/week = _______________gal/yr.

    (7) For Hospitals - varies with type

    (8) Other ___________________.

FORM 3

BUILDING ENERGY USE AUDIT Building No. ________

1. Gross Annual Fuel and Energy Consumption

(Use information provided in Forms 2 and 3 of the Energy Audit Pamphlet for Installations)

	Total Units/Yr	Thousands of BTU's/yr.
a. Oil - gallons	________	________
b. Gas - Cubic Feet	________	________
c. Coal - Short tons	________	________
d. Steam-Pounds x 10^3	________	________
e. Propane Gas - lbs.	________	________
f. Electricity-KW.Hrs.	________	________
g. Total BTU's/Yr		________
h. BTU's x 10^3/Yr/Per Square Foot of Floor Area		________

Form 3 (cont'd) Building No. ________

2. Annual Fuel and Energy Consumption for Heating

	A	B	C
	Fuel Units	Conversion Factor	Thousands of BTU's/Yr.
		x 138 (1)* =	
a. Oil - gallons	________	x 146 (2)* =	________
		x 1.0 (3)* =	
b. Gas - cubic feet	________	x 0.8 (4)* =	________
c. Coal - Short tons	________	x 26000 =	________
d. Steam - Pounds x 10^3	________	x 900 =	________
e. Propane Gas - lbs	________	x 21.5 =	________
f. Electricity-Kw.Hrs.	________	x 3.413 =	________
g. Total BTU's			________
h. BTU's x 10^3/Yr Per Square Foot of Floor Area			________

3. Annual Fuel and Energy Consumption for Domestic Hot Water

	Fuel Units	Conversion Factors	Thousands of BTU's/Yr
a. Oil - Gallons		x 138(1)* =	
	________	x 146(2)*=	________

* Use for (1) No. 2 oil; (2) No. 6 oil; (3) Natural Gas; (4) mfg Gas

Form 3 (cont'd) Building No. ___________

	Fuel Units	Conversion Factor	Thousands of BTU's/Yr.
b. Gas - Cubic Feet		x 1.0(3)*=	
		x 0.8(4)*=	
c. Coal - Short Tons		x 26000 =	
d. Steam-Pounds x 10^3		x 900 =	
e. Propane Gas - lbs		x 21.5 =	
f. Electricity-KW.Hrs		x 3.413 =	
g. Total BTU's/Yr			
h. BTU's Yr/PerSq. Foot of Floor Area			

4. Annual Fuel and/or Energy Consumption for Cooling (compressors and Chillers) ___________

	A	B	C
If absorption cooling	Fuel Units	Conversion Factor	Thousands of BTU's/Yr
		x 138 (1)*=	
a. Oil - Gallons		x 146 (2)*=	
		x 1.0(3)* =	
b. Gas - Cubic Feet		x 0.8 (4)*=	
c. Coal - Short Tons		x 26000 =	
d. Steam-Pounds x 10^3		x 900 =	
e. Propane Gas - lbs		x 21.5 =	
f. Total BTU's/yr			

*Use for (1) No. 2 oil; (2) No. 6 oil; (3) Natural Gas (4) Mfg Gas.

Form 3 (cont'd) Building No. __________

g. BTU's/Yr Per Square Foot of Floor Area ______________________________

If Electric Cooling

a. Electricity - KWH __________ x 3.413 = ____________

b. BTU's x 10^3/Yr Per Square Foot of Floor Area

5. Estimated Annual Energy Consumption for Interior Lighting:

a. KWH __________ x 3.413 = ____________

b. BTU's/Yr/Per Square Foot of Floor Area = ______________________________

6. Estimated Annual Electrical Energy Consumption for all Motors and Machines. If Building and Hot Water are not electrically heated: (1)

a. Total Kw. Hrs. __________ Less Kw. Hrs. Lighting ______=______Kw. Hrs.

(Line 1f, Col. A) (Line 5a, Col A)

b. Kw. Hrs/Yr/Sq. ft. Floor Area = ______________________________ (1) (2)

c. BTU's/Yr/Sq ft floor area - (Line 6b) x 3.413 = ____________ (2)

(1) and (2) If building heat and hot water are electrically heated, deduct the Kw. Hrs./Yr/Per sq. ft. and BTU's/Yr/Sq.ft. for heating and hot water. (Lines 6b and 6c)

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